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THE APPLICATION OF STATISTICAL METHODS TO THE DATA ON THE TRENTON ARGILLITE CULTURE[1]

By CLARK WISSLER

THE writer will briefly consider the suggestion of Mr. Leslie Spier that statistical methods can be applied to the tabulated positions of artifacts and pebbles in the Trenton deposit. Perhaps more than any other phase of anthropological research, archeology is languishing for the want of improvements in method. Those who work in other sciences know that a great deal depends upon the method of handling data, but current archeology itself furnishes good examples of this as in the far reaching results of Dr. Kidder's study of pottery, Mr. Nelson's decisive chronological determinations in the Galisteo pueblo group, and lastly Professor Kroeber's suggestive chronological classification of sites near Zuñi. In each case it was a matter of method. Mr. Spier has also made an important contribution in pointing the way to the use of much more precise methods of handling stratigraphic observations.

Mr. Spier's specific point is that the tabulation of his finds according to successive depths in inches gives a typical frequency curve. Following up this suggestion we may apply certain well-known criteria to the data.

1. First we may ask, if the series of artifacts from the different trenches are homogeneous, or are true samples of the same general distribution. Inspection indicates that the several distributions tend to the same form. Calculating the averages (A) and variabilities (σ) in the usual way we get the following for Spier's frequency tables:—

	n	A	σ
I	25	8.1	± 3.80
II*a*	42	9.9	± 4.35
II*b*	53	10.2	± 4.67
III	47	18.8	± 4.84
IV	55	8.0	± 3.21
V	46	7.0	± 2.52

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[1] Read by title before the American Anthropological Association at Washington, D. C.

It will be noted that the values of A are similar except for III. In this case there are no artifacts in the first 9 inches of deposit, so that if we deduct this we have A = 9.8. The maximum difference in A would then be 2.9 and the certainty of this would be expressed by ± 0.82. This cannot be considered as indicating a certain difference in the true values for A. Since all measurements were taken from the line of contact with black soil, we introduce another variable into our series, which though obviously small in value still must tend to disturb our averages. Even the slightest allowance for this would leave much less reason to consider the distributions as independent.

We are also able to compare these data with those of Volk and Mercer from trenches in Lalor field.

Volk..........	1894	109	7.8	± 2.87
	1897	65	11.2	± 5.31
Mercer........	1897	56	9.8	± 4.87

With one exception these fall within the preceding limits. Mr. Volk's 1897 finds give A = 11.2 which gives us a maximum difference of 11.2 − 7.0 (our lowest average) = 4.2. The certainty of this value for A = ± 0.77. While this approaches a real difference even when discounted for the plane of contact variable, it is but one case out of seven. Further we must note the possible change of the plane of maximum frequency as indicated in III and that we are comparing trenches in separate sites. Further, the measurements of Mr. Volk are all taken together while each of our series represents a single section of a trench.

In conclusion it may be said that we are justified in treating all these distributions as parts of the same series, or that the same causes of deposition acted on all. There is then a plane of maximum deposition running through the entire deposit, the direction of which is indicated by the averages for our different series.

2. The next point to consider is, Are the artifact series component parts of the pebble series? This is a much simpler problem than the preceding because we can compare the data from each trench separately. First, let us take Mr. Spier's series for V. The pebble

series contains 194 cases giving an average of 9.1 ± 4.37. As stated above, the artifact series for the same trench is 7.0 ± 2.52. The difference between these is 2.1 ± 0.53. While this is a variation that falls near what may be considered a real difference, it is not far enough removed to be positive.

The series of pebbles for III requires special consideration since it was made by two observers. Mr. Hoover, the chief field assistant, carried the trench to a depth of 29 inches at which point Mr. Spier took it. Mr. Spier's count was considerably higher than that of Mr. Hoover and the combined series gives a curve of composite appearance. As no sifter or gauge was used to determine the minimum size of pebbles, individual differences in the observers should be expected. The entire series was as follows:—

Pebble Series for III

Inches	Pebbles	Inches	Pebbles
0	2	24	33
1	4	25	24
2	4	26	24
3	4	27	23
4	1	28	20
5	2	29	31
6	5	(Change of Observers)	
7	5	30	40
8	3	31	34
9	5	32	30
10	9	33	21
11	5	34	14
12	9	35	13
13	8	36	9
14	9	37	7
15	17	38	1
16	21	39	1
17	32	40	1
18	32	41	1
19	32		——
20	41	Total.....	675
21	30	Average depth..	23.31 +
22	40		σ = 7.55 +
23	33		

Comparing this with the artifact series for the same trench we get a difference of 4.5 ± 0.77. As it stands this is a positive difference. We note, however, that the distribution is not altogether symmetrical and that the difference corresponds to the change in observers.

The best way to approach this case seems to be the following: Let us assume that:

1. Sizes of pebbles are constant.
2. That both observers are equally accurate in count and measure.
3. That observer *y* took smaller pebbles than *x*.

Then it should follow that *y*'s curve would have the same base as *x*'s and both be typical and symmetrical. In this case *y* and not *x* completed the last quarter (approximately) of the series. Under the previous assumption *y*'s count for a given ordinate will exceed *x*'s by a constant ratio of increment. Had either alone completed the series the average would have been the same, one having a larger number of cases than the other. In this case it is clear that *x* was on the last quarter of a typical distribution curve and when *y* took up the count he started with a higher value but reached the same point on the base as would *x* had he continued. Since *y*'s other pebble curve is symmetrical and the joint obtained curve has the approximate form of the theoretical curve in our figure, we may consider assumptions 1 and 2 proven.

When we calculate the average for the *xy* curve, the value obtained will be too high because the greater count of *y* is added to one side alone. Just how much reduction should be made to reach the true average is difficult to calculate, but by inspection of the curve as plotted, it appears probable that the corrected average would fall between 19 and 20. In any event the value of the obtained average (23.3 ± 7.55) would be considerably reduced and any such reduction would tend to bring it down to the level of an accidental difference.

From Mercer's published data for his trench in Lalor field, Mr. Spier was able to check out the following:—

56 pebbles	11.7 ± 5.96
31 artifacts	9.8 ± 4.87
	1.9 ± 0.61

Attention should be called to the fact that a series of bone fragments was given by one trench (II*b*). The average for this was 10.2 ± 4.67 which can be shown to be coincident with the artifact series for the same trench.

While all the preceding leaves little ground for differentiating between the pebble and artifact series, it may be noted that in each of the three cases the average for pebbles is actually higher than that for artifacts. Should this hold for a few future cases, it would make it quite probable that there was a slight real difference between the two series. Yet this would not materially affect the main point, that the artifacts and pebbles occur together.

3. We shall now consider the question, can the manner and agency of deposition for pebbles and artifacts be determined by a study of the distribution curves? This is a comparative problem. If we knew just how pebbles are distributed in sand of known origin, we could make a direct inference. Unfortunately, we have at hand no such data for either water or wind deposits.

In the case of artifacts we are somewhat more fortunate. Mr. N. C. Nelson's pottery tables for the refuse heap at San Cristobal Pueblo give us large segments of two typical curves (3 and 4). Here the manner of distribution is known, but we do not know the particular causes that give us this form of curve. That it represents an increase and decline of population is unlikely because another type of pottery tends to be numerically constant throughout. It seems more likely that these curves represent in the main the rise and decline of a culture trait. But these curves represent special types of pottery and not the ceramic trait as a whole. When we take the total number of pottery fragments in the section excavated we find them tending to be constant. The wide fluctuations occur approximately at the nodes of the distributions for the selected types. As the totals stand for each level in the San Cristobal refuse heap, it is difficult to see how they can be interpreted as indicating anything but an average uniform intensity of the ceramic trait as a whole and a fairly constant population. On the other hand, we do have fluctuations appearing as due to the rise of certain popular styles and it is these styles only that give us the typical distribution curve. These assumptions are based upon the idea that the number of pottery fragments finding their way into a refuse heap at a given moment will be proportional to the number of pots in use.

TYPES AND VARIETIES OF POTSHERDS AND THEIR NUMERICAL REPRESENTATION IN EXCAVATED SECTION OF REFUSE HEAP AT PUEBLO SAN CRISTOBAL, NEW MEXICO

Table from N. C. Nelson.

Thickness of Section	Corrugated Ware (1)	Biscuit Ware (2)	Type I. Two and Three Color Painted Ware.	Type II. Two Color Glazed Ware.			Type III. Three Color Glazed Ware	Totals
			Black-on-White Painted Ware (3)	Red Ware, Black or Brown Glaze (4)	Yellow Ware, Black or Brown Glaze (5)	Gray Ware, Black or Brown Glaze (6)	Gray, Yellow, Pink and Reddish Wares, Combination Glaze-and-Paint Design (7)	
1st ft.	57	10	2	24	23	34	5	155
2d "	116	17	2	64	90	76	6	369
3d "	27	2	10	68	18	48	3	173
4th "	28	4	6	52	20	21	..	131
5th "	60	15	2	128	55	85	..	345
6th "	75	21	8	192	53	52	1?	402
7th "	53	10	40	91	20	15	..	229
8th "	56	2	118	45	1	5	..	227
9th "	93	1 (?)	107	3	..	..	..	203
10th ft. =8 in.	84 (126)	1 (?)	69 (103)	..	..	..	..	153

In many respects the chipping industry represented in our trenches is comparable to a ceramic trait elsewhere. Now the total ceramic curve at San Cristobal is not of the symmetrical form found at Trenton. It is only two curves for selected types of pottery that take this form. These are then curves of specific styles in ceramic art and not the typical distribution for the ceramic art of San Cristobal as a whole. If this is correct then we should not expect to find our artifacts at Trenton taking the distribution forms we have shown, unless they were deposited by some agency other than human. It may be objected that this chipping may be a single style pulsation like one of Mr. Nelson's types of pottery. The difficulty in accepting this view is that we have no other associated traits. It is scarcely conceivable that such a trait should go out without parallel displacing traits. The objection does not therefore seem a valid one, and we have in these facts of distribution another reason for considering the Trenton deposit to be a geological phenomenon. It would be conceivable that the Trenton curve represents merely the rise and decline of population, if it were not for the facts of pebble distribution and the horizontal alignment of artifacts. These alone seem sufficient objection to such an interpretation.

We may also compare some shell-heap data. In the report of Loomis and Young on a shell-heap in Maine (The American Journal of Science, 1912, pp. 17–42) we have a diagram giving the precise locations for all artifacts in a given unit of space. Unfortunately, the table of measurements is not given but an approximate tabulation can be checked out that will serve our purpose. Accordingly, Mr. Spier has made the following compilation for a two inch interval.

Inches	Unworked Bones	Worked Bones	Worked Stone	Pottery	Total
3	6	1	..	..	7
5	4	1	..	1	6
7	3	..	..	..	3
9	7	2	..	..	9
11	11	5	1	2	19
13	3	..	1	..	4
15	1	2	1	1	5
17	5	1	..	..	6
19	3	1	..	..	4
21	1	..	..	..	1
23	17	2	3	2	24
25	..	..	1	..	1
27	5	..	1	..	6
29	8	2	1	..	11
31	..	2	1	..	3
33	..	1	..	..	1
35	23	7	..	..	30
37	3	..	..	..	3
39	1	..	..	..	1
41	2	1	..	1	4
43	3	..	..	..	3
45	1	..	1	..	2
47	3	..	..	..	3
49	31	1	..	..	32
51	6	..	..	..	6

It will be noted that on the average every twelfth inch marks a layer of great frequency with more or less scattered finds between. If, for example, we divide the diagram according to these points of greatest frequency, we get four zones containing 44, 44, 52 and 48 finds respectively. There is no good reason why the unworked bone in this table is not comparable to the bone fragments in our Trenton trench II*b*, but there is no similarity between their distributions.

Thus when we compare two typical examples of deposition incident to cultural activity we do not consistently find the normal type of frequency curve, whereas at Trenton all our finds, bone, pebbles, and artifacts, have this single type of distribution. Hence until some additional data are brought forward, we must consider the depositing agent at Trenton to be geological.

The tendency of geologists has been to interpret this site as a wind deposit. It is now necessary for them to show that wind will deposit pebbles of this size and in such a vertical order, because the preceding observations are far more consistent with the assumption that water was the agent of deposition.

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